



Making the Basic Microbiology Laboratory an Exciting and Engaging Experience

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INTRODUCTION

Getting students interested, excited, and engaged while they learn basic microbiology laboratory techniques can be challenging, especially when working with non-biology majors including nursing students and allied health students. The lack of interest is often explained by the fact that most non-biology majors take this course as a requirement for their program and not by personal choice. This can create a considerable obstacle in learning basic techniques and skills that can foster critical thinking across a curriculum. In spite of these challenges, a good instructor can promote the necessary techniques and approaches that will keep students interested, engaged, and excited about the basic microbiology laboratory. Recently, Marintcheva developed a rather smart approach to motivate students to learn biology vocabulary using Wikipedia (2). This approach is appealing to students because they can relate to the readily available online resources. Another team has recently developed a strategy to improve student performance in fundamentals of biotechnology (1) by supplementing lectures with student-driven discussion using current news and scientific literature. In general, basic microbiology laboratory techniques are taught as discrete laboratory exercises and independently of each other. For example, the Gram staining procedure is taught in one exercise and the streak plate method in another. Unfortunately, students do not make connections between these basic techniques and, more importantly, do not understand the relevance of learning all these techniques.

Over the past few years, we have developed an approach that has helped keep non-biology majors excited and engaged throughout a basic microbiology laboratory course. In this paper, we demonstrate how this approach can enhance student learning and further engage and excite students in understanding course content.

PROCEDURE

We found that we can empower students in learning basic laboratory techniques by creating a sense of ownership early in the laboratory course. By having the students isolate an unknown bacterium from their environment as the course begins, interest is stimulated early as to what they may possibly have isolated. The isolated unknown should be run in parallel with known characterized cultures provided by the instructor. This approach allows students to see connections between laboratory exercises performed week to week while following “their” unknown.

Isolation of bacteria from the environment

Students are challenged to find an organism from their environment that they will work with for the remainder of the course. They are provided with a Ziploc bag containing either a Brain Heart Infusion (BHI) agar plate or a Nutrient agar plate and a cotton swab that will allow them to swab a location of their choice. Students should be asked to stay away from possible infectious material and to avoid sampling from embarrassing locations as the origin of the sample will be shared in class. We recommend having students discuss possible locations with the instructor before leaving class. Have students swab their plates at the site and bring the plate and swab in the Ziploc bag back to class. Typically, students have sampled from dollar bills, electronic devices, and door handles. After appropriate incubation at 37°C, ask students to describe the morphology of colonies and to determine the number of colony types, and to choose one type of colony as their “corner of the universe” (COU) for the rest of the semester.

Choosing their COU is a very important turning point of this semester-long project, as they will have to characterize their COU and attempt to identify it. We have found that students become excited when they find out that the organism they will be working on is an organism they have isolated themselves. They are more eager to know about that organism and to characterize it. It is crucial to explain to students how each technique covered in class will help them characterize their COU. Students are more motivated when they understand how a particular technique applies to their case.

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Obtaining a pure culture

Using aseptic technique, ask students to inoculate a Tryptic Soy Broth, Nutrient Broth, or BHI broth with their chosen COU. After incubating the appropriate broth culture at 37°C for 48 hours, have students perform a streak plate to obtain single isolated colonies. Explain to students that in the next few weeks they will be learning techniques crucial for characterizing and identifying their COU. Students may need some assistance at this point to ensure that they select a bacterium as their COU and not a fungus. Furthermore, it is important to stress that any unknown organism should be treated as a potential pathogen.

Characterization of the pure culture

Students should use their COU as they move through the microbiology laboratory curriculum. For instance we routinely use the COU with the following basic microbiology laboratory exercises (found in most introductory laboratory manuals).

- Gram stain
- Temperature requirement
- Oxygen requirement using thioglycollate medium
- Effect of disinfectants on bacterial growth
- Antimicrobial drugs using the Kirby-Bauer disk diffusion method

Bacterial identification tests

Before starting experiments on bacterial identification, it is necessary to explain to students that they will use a variety of tests including differential and selective media for identification of their COU. Put a particular emphasis on the fact that though the goal is to identify the organism, not all the data collected will lead to a definitive conclusion. More testing beyond what is used in most introductory laboratories may be needed. This is a good time to introduce the concept of bacterial identification using genetic analysis. When running the traditional “unknown” exercises, students are often afraid they will not properly identify the right organism obtained from the instructor. They develop a level of stress that causes them to lose focus on the methodology and the approach for identification of the organism. When students understand that even the instructor does not know the true identity of the COU, they are more relaxed

and can focus on the best methodology for identification. They show more involvement and they are more active in developing strategies for identification. Nevertheless, most students need guidance through the identification process.

Safety issues

As stated in the procedure, students will discuss isolation areas with the instructor prior to sampling. In addition, all swabs and plates will be brought back to class and disposed of properly.

The ASM advocates that students must successfully demonstrate the ability to explain and practice safe laboratory techniques. For more information, read the laboratory safety section of the ASM Curriculum Recommendations: Introductory Course in Microbiology and the Guidelines for Biosafety in Teaching Laboratories, available at www.asm.org.

CONCLUSION

We have seen tremendous improvement in student attitudes toward the basic microbiology laboratory when incorporating this semester-long project as opposed to the traditional way of teaching this course. When asked about this approach, students have reported that this teaching format has changed their opinion about microbiology and motivated many to change their major to biology.

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